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THE FISH FAUNA OF THE PLAYA DEL REY LOCALITY, A SOUTHERN CALIFORNIA MARINE PLEISTOCENE DEPOSIT

By JOHN E. FITCH

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David K. Caldwell
Editor

THE FISH FAUNA OF THE PLAYA DEL REY LOCALITY, A SOUTHERN CALIFORNIA MARINE PLEISTOCENE DEPOSIT[1]

By JOHN E. FITCH[2]

ABSTRACT: An assortment of fish remains excavated since 1935 from the Playa del Rey deposit, Los Angeles County, California, contained nearly 2,000 recognizable items. Elasmobranchs were represented by teeth, vertebrae, stings, and body spines; teleosts by otoliths, pharyngeal teeth, vertebrae, and other bony parts. Most of the 47 species identified from these remains still inhabit quiet coastal waters adjacent to Los Angeles County; however, a few no longer are constituents of the local fauna, but can be found living in warm tropical waters several hundred miles to the south. Thus, the fish remains from this formation typify a shallow-water, sandy or sandy-mud habitat at a time when local ocean temperatures were several degrees warmer than they are today.

Southern California is blessed with numerous Pleistocene outcroppings containing rich fossil assemblages. Mollusks were described from some of these more than a century ago (Conrad, 1855), and in the ensuing 105 years, at least 90 other authors contributed additional information on this group (Valentine, 1961). On the other hand, published information on southern California's Pleistocene fish fauna is limited to a single paper (Kanakoff, 1956).

PLAYA DEL REY LOCALITY
(Palos Verdes Sand)

The Playa del Rey or "Lincoln Avenue deposit" was first brought to public attention in 1937 when Willett recorded a mixed molluscan fauna containing 296 species. These had been screened and sorted from several tons of fossiliferous material during 1935 and 1936. In addition to mollusks, this deposit contained remains of at least 28 species of crustaceans, 3 echinoderms, 1 bryozoan, 2 marine mammals, and "a goodly representation of fish material. . . ." (Willett, 1937).

The habitat apparently was a fine-grained silty sand, typical of a quiet-water embayment 10 to 12 fathoms deep (Willett, 1937; Valentine, 1961). Among the mollusks reported by Willett, 261 live in the same latitude today, while 19 are found only farther to the south, many being confined to Mexican waters. A deep-water or northern fauna was also mixed in, but these remains, because of their worn appearance and rarity, were believed to be detrital, having washed in from adjacent areas.

[1]This study was supported by a research grant (GB-1244) from the National Science Foundation.

[2]Research Associate, Los Angeles County Museum; Research Director, California State Fisheries Laboratory, Terminal Island.

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TABLE 1

List of Fish Remains Found in the Playa del Rey (Pleistocene) Deposit

Scientific name	Common name	Type and number of remains found				
		teeth	otoliths	vertebrae	stings	other
	ELASMOBRANCHS					
Notorynchus maculatus	sevengill shark	4				
Alopias vulpinus	thresher shark	2				
Carcharodon carcharias	great white shark	6		4		
Isurus glaucus	bonito shark	2				
Carcharhinus spp.	carcharhinid sharks	26				
Galeorhinus zyopterus	soupfin shark	15				
Scoliodon longurio	sharpnose shark	1				
Sphyrna spp.	hammerhead sharks	3		17		
Squatina californica	angel shark	10		8		
Raja spp.	skates			8		3†
Urolophus halleri	round stingray				164	
Myliobatis californicus	bat ray	205				
	unidentified sharks	3				
	TELEOSTS					
Engraulis mordax	northern anchovy		68			
Merluccius productus	hake		24			
Paralichthys californicus	California halibut		1			
Citharichthys sordidus	Pacific sanddab		29			
Citharichthys stigmaeus	speckled sanddab		238			

TABLE 1 (continued)

Scientific name	Common name	Type and number of remains found				
		teeth	otoliths	vertebrae	stings	other
Citharichthys spp.	sanddabs		23			
Lyopsetta jordani	slender sole		1			
Pleuronichthys ritteri	spotted turbot		1			
Parophrys vetulus	English sole		1			
Leuresthes tenuis	grunion		6			
Atherinopsis californiensis	jacksmelt		3			
Atherinops affinis	topsmelt		1			
Sphyraena argentea	California barracuda		1			
Anisotremus davidsoni	sargo		1			
Micropogon ectenes	berrugato		2			
Umbrina roncador	yellowfin croaker		13			
Genyonemus lineatus	white croaker		217			
Roncador stearnsi	spotfin croaker		19			
Menticirrhus undulatus	California corbina		1			
Cynoscion nobilis	white seabass		5			
Cynoscion reticulatus	striped corvina		4			
Seriphus politus	queenfish		275			
Phanerodon furcatus	white seaperch		9			
Cymatogaster aggregata	shiner perch		6			
Pimelometopon pulchrum	California sheephead					7‡
Sebastodes paucispinis	bocaccio		6			
Sebastodes jordani	shortbelly rockfish		2			
Sebastodes aurora	aurora rockfish		1			

TABLE 1 (continued)

Scientific name	Common name	Type and number of remains found				
		teeth	otoliths	vertebrae	stings	other
Sebastodes diploproa	splitnose rockfish		1			
Sebastodes rhodochloris	swordspine rockfish		1			
Sebastodes spp.	rockfishes		13			
Chitonotus pugetensis	roughback sculpin		1			
Lepidogobius lepidus	bay goby		1			
Porichthys notatus	plainfin midshipman		161			
Porichthys myriaster	specklefin midshipman		15			
Otophidium taylori	spotted cusk-eel		83			
Otophidium scrippsae	basketweave cusk-eel		140			
Lepophidium negropinna	giant cusk-eel		2			
	unidentifiable teleosts		33	25		7**

†spines from skate "wings"

‡pharyngeal bone (1) and teeth (6)

**pharyngeal bone (1) and assorted fin and vertebral spines (6)

Although Willett reported that some 700 specimens of fish remains were saved, Kanakoff (1956) listed only 380 items representing 21 species. This was all of the fish material from the "Lincoln Avenue deposit" still in the Los Angeles County Museum at that time. Apparently many of the items mentioned by Willett had been misplaced in the ensuing 20 years.

Because this site was rich in fish remains, and still could be excavated, many additional pounds of fossiliferous matrix were screened in 1963 to obtain many of the items reported herein. To make this report as complete as possible, I reexamined the specimens listed by Kanakoff for LACMIP 59, and incorporated them with the abundant material obtained since 1956. Thus, my paper lists all of the fish remains from the Playa del Rey presently preserved in Los Angeles County Museum (Table 1).

THE FISH FAUNA

Teleost remains were represented by 1,409 otoliths and otolith fragments, 2 pharyngeal bones, 6 pharyngeal teeth, 25 vertebrae, and 6 miscellaneous spines and similar structures. In addition, there were 276 teeth, 37 vertebrae, 164 stings, and 3 miscellaneous items from sharks, skates, and rays. I was able to determine names for all but 34 of the 1,409 otoliths, and for the pharyngeal teeth, as well as all but three of the elasmobranch remains.

Croaker (family Sciaenidae) otoliths, with 535 individuals in seven genera and eight species, were the most abundant of these structures. Six teleost fish families were represented by only a single species each, and in four of these (Sphyraenidae, Pomadasyidae, Gobiidae, and Cottidae) there was but a single otolith. A pharyngeal bone and teeth were from sheephead, *Pimelometopon pulchrum*. The various unidentified teleost vertebrae and other assorted bones probably came from some of the same species that left otoliths. The unidentified otoliths were too fragmental or too badly worn to assign names; they too probably were from the same species as those identified.

The elasmobranch remains were from at least 12 species belonging to 12 genera in 8 families. Plate-like jaw teeth of bat rays, *Myliobatis californicus*, and stings (caudal spines) of either this species or of round stingrays, *Urolophus halleri*, comprised over 75 per cent of the 480 elasmobranch remains.

SYSTEMATIC ACCOUNT

Hexanchidae—cow sharks

Notorynchus maculatus Ayres—sevengill shark

On rare occasions young individuals are taken off southern California, particularly in Santa Monica Bay. Their usual range is from about northern British Columbia to Monterey Bay. Specimens exceeding 8 or 9 feet are seldom seen, but they are reported to attain 15 feet. They are usually captured near the bottom in water 50 to 600 feet deep.

Four sevengill shark teeth (Figure 1) were screened from this deposit. These are extremely difficult to distinguish from sixgill shark teeth (*Hexanchus* sp.), but the serrations on sevengill teeth are slightly larger.

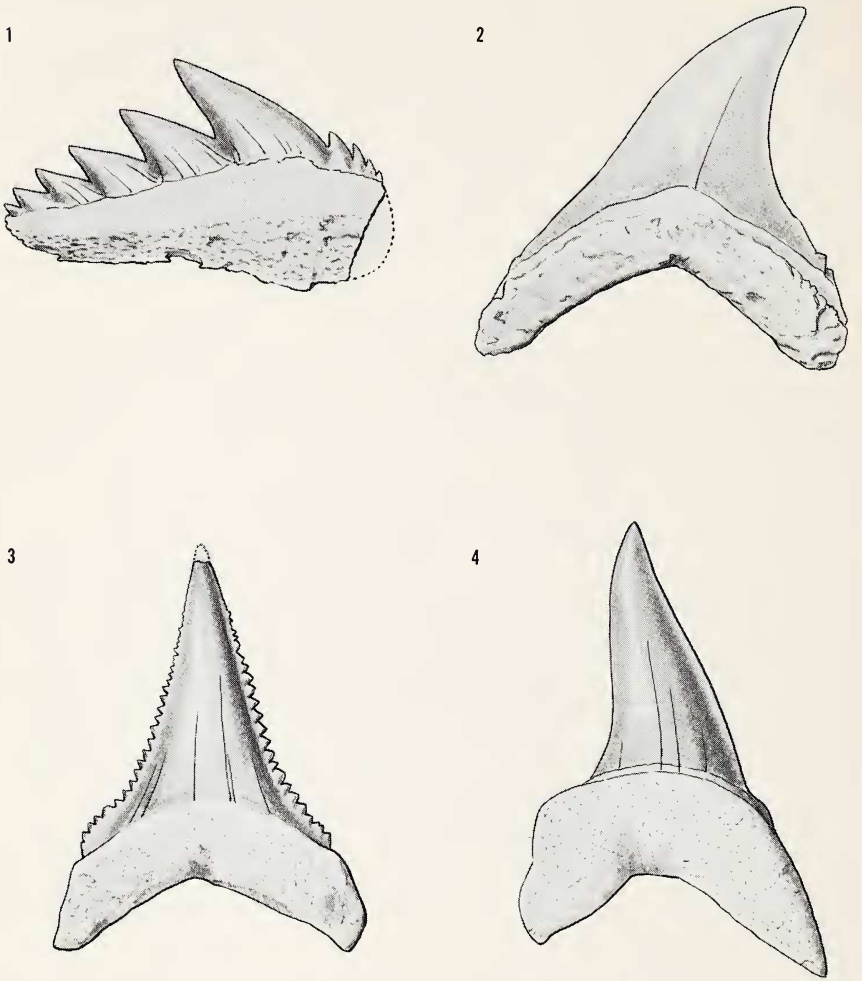


Figure 1. Lower right lateral tooth of sevengill shark, *Notorynchus maculatus* (width of base to break 20.5 mm, LACMIP 59).

Figure 2. Upper left lateral tooth of thresher shark, *Alopias vulpinus* (width of base 5.8 mm, LACMIP 59).

Figure 3. Lower right anterior tooth of great white shark, *Carcharodon carcharias* (width of base 19.4 mm, LACMIP 59).

Figure 4. Lower left lateral tooth of bonito shark, *Isurus glaucus* (width of base 17.7 mm, LACMIP 59).

Lamnidae—mackerel sharks

Alopias vulpinus (Bonnaterre)—thresher shark

Thresher sharks are known from temperate and tropical waters of all world seas. On our coast, this species ranges from Vancouver Island, British Columbia, well into Mexican waters. They are also fairly abundant on the high-seas, usually at or near the surface. The individuals most likely to visit shallow waters near shore are young. An 18-foot specimen is the largest known from our coast, but most are shorter than 8 feet, with the tail making up about half the length. Two thresher shark teeth (Figure 2) were found in this deposit.

Carcharodon carcharias (Linnaeus)—great white shark

This shark also inhabits all world seas, and has been captured on numerous occasions along our coast between Washington and Ensenada, Baja California. The modern-day record of 35 feet may be an unreliable estimate; most Californian specimens are shorter than 12 feet. This species probably is responsible for most of California's shark attacks, usually made in relatively shallow water near shore. Six teeth (Figure 3) and four vertebrae were found in this deposit.

Isurus glaucus (Müller and Henle)—bonito shark

Our bonito shark is possibly identical to its Atlantic relative, but on the Pacific coast it ranges only from about Monterey Bay to the vicinity of Magdalena Bay, Baja California. It or a similar species occurs well offshore, where it is captured on longline gear. Bonito sharks are abundant in our waters, but seldom exceed 8 feet; however, they may attain lengths of 13 feet. They usually are found at or near the surface over fairly deep water. Two of the shark teeth were from this species (Figure 4).

Carcharhinidae—requiem sharks

Carcharhinus spp.—carcharhinid sharks of several species

These are typically tropical sharks along the Pacific coast, yet at least four species have been captured off southern California at one time or another. While rare in our waters, all become abundant in more tropical waters, especially around offshore islands and land masses, although a few are pelagic forms. Identical or similar species are known from most world seas. Some species probably reach 15 feet, while others may never exceed 5. In our area, they usually are captured near the bottom close to shore.

Considerable confusion exists regarding speciation within this genus, mainly because intraspecific variation is not fully understood. Their teeth appear distinguishable at the species level, but because of general confusion among taxonomists as to which species are valid, it seems wise not to try placing names on the 26 *Carcharhinus* teeth (Figures 5 and 6) found in this deposit.

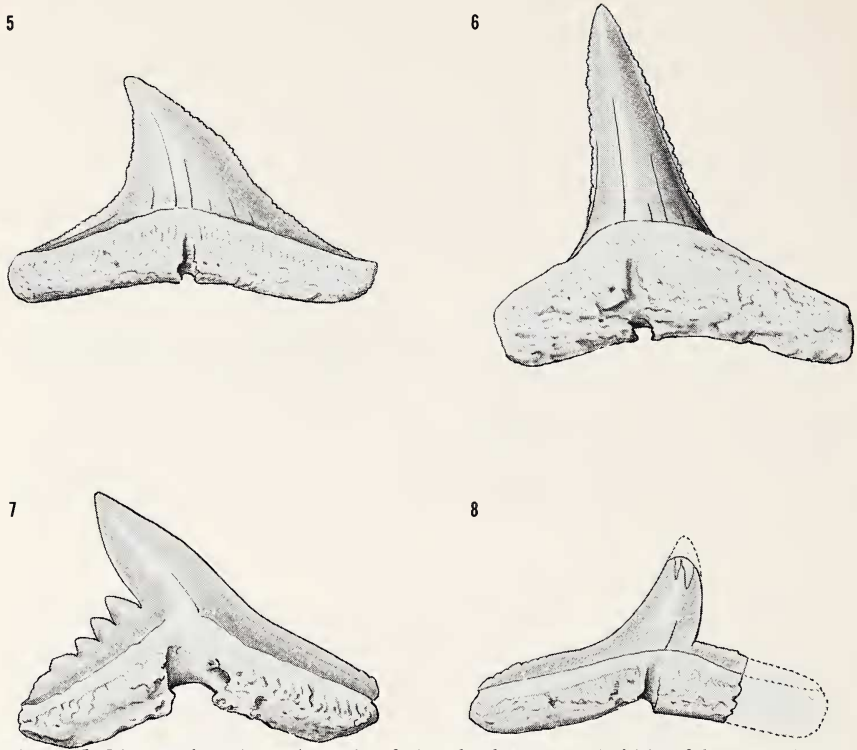


Figure 5. Upper right lateral tooth of *Carcharhinus* sp. (width of base 17.6 mm, LACMIP 59). When fresh, the margins of this tooth were finely but evenly serrate.

Figure 6. Lower left lateral tooth of *Carcharhinus* sp. (width of base 13.7 mm, LACMIP 59). When fresh, the margins of this tooth were finely but evenly serrate.

Figure 7. Lower left lateral tooth of soupfin shark, *Galeorhinus zyopterus* (width of base 6.6 mm, LACMIP 59).

Figure 8. Lower right lateral tooth of sharpnose shark, *Scoliodon longurio* (width of base to break 5.8 mm, LACMIP 59). The shoulders of this tooth were finely serrate when fresh.

Galeorhinus zyopterus Jordan and Gilbert—soupfin shark

Soupfin sharks are abundant between northern British Columbia and Abreojos Point, Baja California. The males typically inhabit waters in the southern part of this range, while females prefer the northern. This small species seldom exceeds 6 feet. They usually are found at or near the bottom in several hundred feet of water, but sometimes are in quite shallow areas. There were 15 soupfin shark teeth in this deposit (Figure 7). In the report by Kanakoff (1956), I mistakenly identified these as leopard shark, *Triakis semifasciata,* teeth.

Scoliodon longurio (Jordan and Gilbert)—Pacific sharpnose shark

This small, tropical species has been seen once or twice in recent years off southern California, occurring as far north as Long Beach. Adults are usually extremely abundant from about Magdalena Bay, Baja California, to Peru. Some individuals may reach 3½ feet, but most do not exceed 2 or 3. They usually inhabit quiet waters near shore, where they can be caught at or near the bottom. One tooth (Figure 8) was recovered from the Playa del Rey deposit.

Sphyrnidae—hammerhead sharks

Sphyrna spp.—hammerhead sharks, species undetermined

Three species of these tropical sharks have been recorded from our waters in modern times. The largest hammerheads may reach 15 feet, although individuals exceeding 8 feet are rare. During summer months of warmwater years, hammerheads are fairly abundant off California to about Santa Bar-

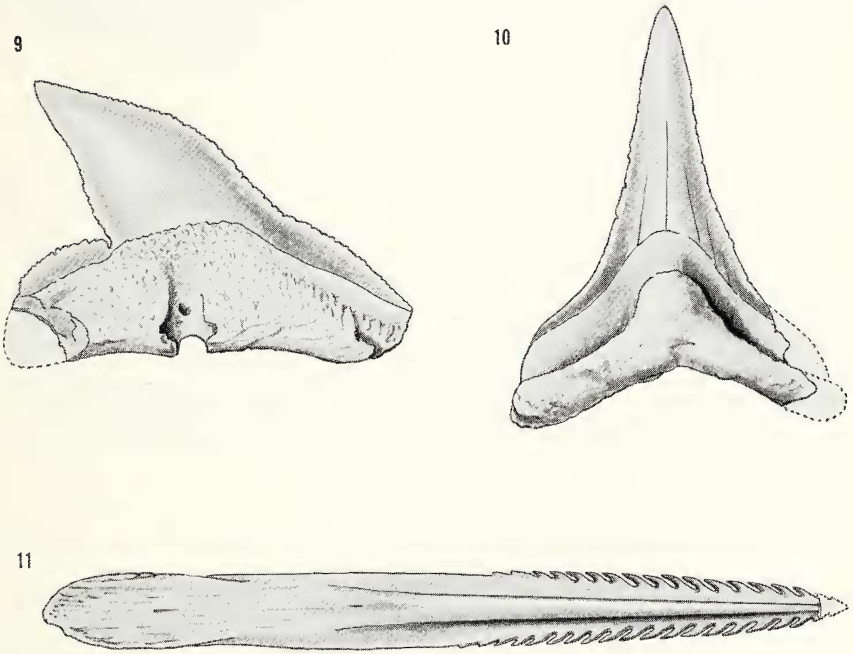


Figure 9. Upper left lateral tooth of hammerhead shark, *Sphyrna* sp. (width of base to break 12.8 mm, LACMIP 59). The margins of this tooth were finely but evenly serrate when fresh.

Figure 10. Lower anterior tooth of angel shark, *Squatina californica* (width of base 4.7 mm, LACMIP 59).

Figure 11. Caudal "sting" of round stingray, *Urolophus halleri* (length of sting to break 32.8 mm, LACMIP 59).

bara. They usually are found at or near the surface over the continental shelf, sometimes entering quiet waters near shore and sometimes staying many miles offshore. Our present (inadequate) knowledge of their dentition, precludes placing specific names on the 3 teeth (Figure 9) and 17 vertebrae from this deposit that were definitely from hammerheads.

Squatinidae--angel sharks

Squatina californica Ayres—Pacific angel shark

Angel sharks are reported in the literature from Alaska, but not from British Columbia. Most of our recent records place this species within the area bounded by Oregon and Magdalena Bay. They also are found in the northern Gulf of California. Although they are said to reach 5 feet, the largest of several hundred examined during the past 20 years was slightly shorter than 4 feet and weighed 31 pounds. They usually abound on sandy bottoms from just outside the surf zone to depths of several hundred feet. They were represented in this deposit by 10 teeth (Figure 10) and 8 vertebrae.

Rajidae—skates

Raja spp.—skates of various species

Six species of skates are known from Californian waters and several additional species are known from off Mexico. Skates usually live on the bottom in water deeper than 50 feet, but occasional young individuals are captured in shallow water near shore. Some attain 6 to 8 feet, but most species apparently are shorter than 2. They are especially abundant on sandy-mud or firm-mud bottoms. Some species have large spines scattered over their upper surfaces, and the adult males of most species have numerous, strong, curved spines near the tips of their "wings." There were 8 skate vertebrae in this deposit, and 3 spines from skate "wings." At present, I cannot tell if these remains represent more than one species, but they appear to be from at least two.

Dasyatidae—stingrays

Urolophus halleri Cooper—round stingray

Round stingrays have been captured at Humboldt Bay, California, but are unusual north of Point Conception. They are most common from about Ventura to Panama, often being extremely abundant during the summer in shallow bays, estuaries, sloughs, and along the outer coast. They are especially fond of areas where the bottom is sandy or sandy-mud. Of several thousand examined during the past 20 years, the largest was 22 inches long. All of the 164 stings (Figure 11) found in this deposit have been assigned to this species, although some may have been from other stingrays. They were believed to be *Urolophus* mainly because they were too small for adult bat rays (*Myliobatis*) or diamond stingrays (*Dasyatis*), and also because *Urolophus* occurs in our

waters in such profusion today, compared with other stingrays. While not absolute, these criteria do seem of sufficient strength to warrant this identification.

Myliobatidae—eagle rays

Myliobatis californicus Gill—bat ray

Bat rays are abundant between southern Oregon and Magdalena Bay, Baja California, and also are found in the upper Gulf of California. They attain widths slightly over 4 feet and weights to 209 pounds. They usually inhabit shallow, quiet embayments, but also abound offshore in depths to at

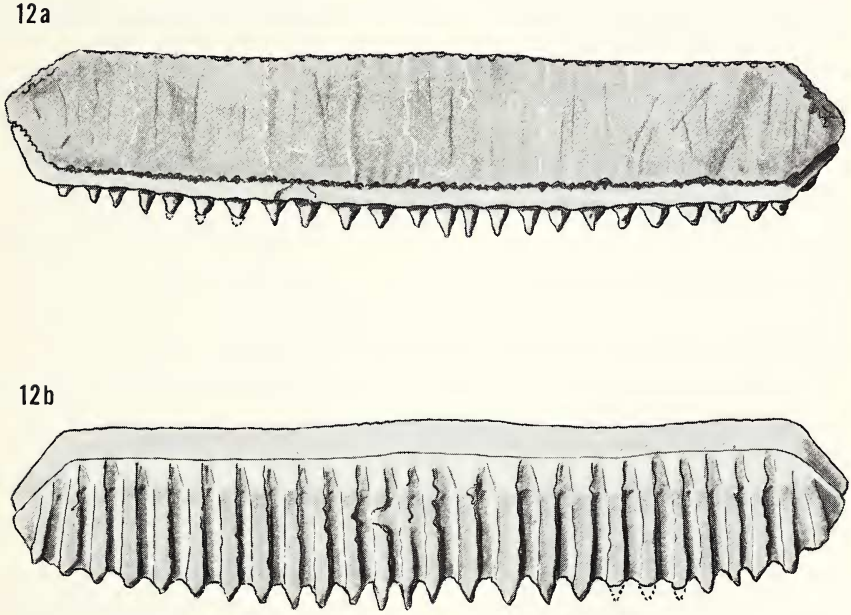


Figure 12. Median tooth of bat ray, *Myliobatis californicus:* a. upper "crushing" surface, b. under side (greatest width 32.0 mm, LACMIP 59).

least 200 feet. Bat rays wreak considerable havoc among shallow-water bivalves, and are especially fond of young oysters, crushing the shells of these and other mollusks with their heavy, plate-like teeth, 205 of which were found in this deposit (Figure 12).

Unidentifiable sharks

Three shark teeth screened from the Playa del Rey deposit were so badly worn they could not be identified, even to family, but probably do not represent additional species.

Engraulidae–anchovies

Engraulis mordax Girard–northern anchovy

Northern anchovies are small schooling fishes that range throughout most of the area between the north end of Vancouver Island and Magdalena Bay. At times they are found 100 miles or more offshore, but most "observed" schools are near shore, sometimes in the surf zone and in the innermost channels of harbors, back bays, and estuaries. They are usually at or near the

Figure 13. Right sagitta of northern anchovy, *Engraulis mordax* (length 4.1 mm, LACMIP 59). Left, outer face; right, inner face.

surface but many are found in the stomachs of bottom-living predators caught in 600 to 800 feet of water. Most of the 68 anchovy otoliths (Figure 13) in the Playa del Rey deposit were in poor condition, more from deterioriation than from wear and tear such as would have occurred if they had settled out in an active surf area.

Merlucciidae–hakes

Merluccius productus (Ayres)–Pacific hake

Pacific hake range from the Gulf of Alaska to Cedros Island, and offshore for 350 miles or more. During some periods, hake are caught in shallow water near shore, but mainly they inhabit areas near the bottom fairly well offshore. They seem to prefer living above sandy or sandy-mud bottoms,

Figure 14 Left sagitta of hake, *Merluccius productus* (length 8.8 mm, LACMIP 59). Left, outer face; right, inner face.

sometimes to depths of nearly 500 fathoms but they are caught mostly in 20 to 100 fathoms. Hake otoliths (Figure 14) are quite thin and delicate, and most of the 24 in this deposit were badly deteriorated.

Bothidae–lefteyed flounders

Paralichthys californicus (Ayres)–California halibut

During extensive periods when coastal waters are warm, California halibut are caught far north of their typical range. Thus they have been caught

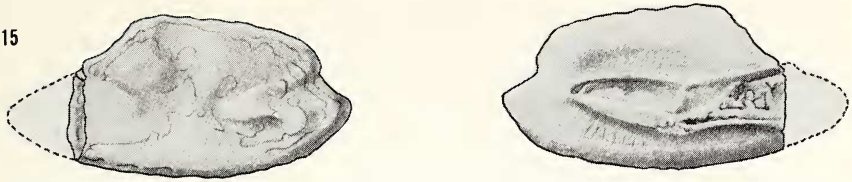
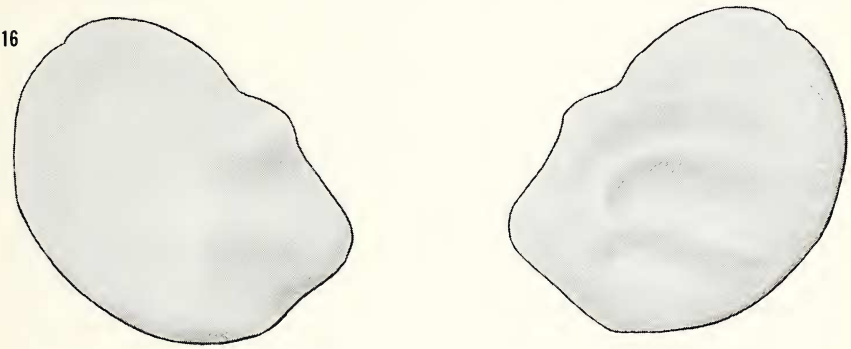


Figure 15. Left sagitta of California halibut, *Paralichthys californicus* (length to break, 7.0 mm, LACMIP 59). Left, outer face; right, inner face.

off the Klamath River, California, but are not common north of San Francisco, ranging from there to Magdalena Bay. They prefer sandy or sandy-mud bottoms in water shallower than about 25 fathoms. There was a single California halibut otolith (Figure 15) in this deposit.



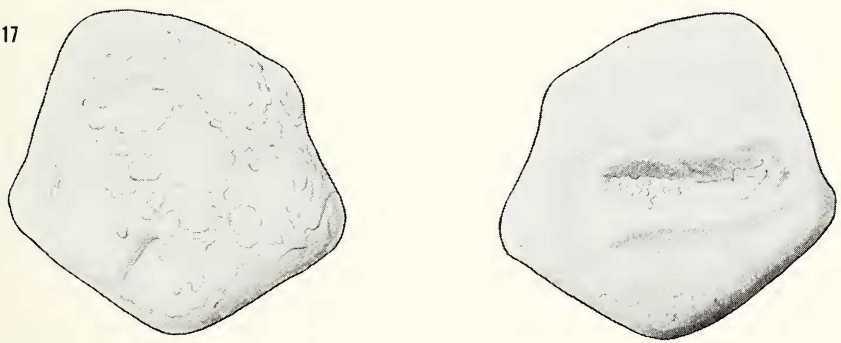


Figure 16. Right sagitta of Pacific sanddab, *Citharichthys sordidus* (length 5.8 mm, LACMIP 59). Left, outer face; right, inner face.

Figure 17. Right sagitta of speckled sanddab, *Citharichthys stigmaeus* (length 2.4 mm, LACMIP 59). Left, outer face; right, inner face.

Citharichthys sordidus (Girard)--Pacific sanddab

Pacific sanddabs range from about southern Alaska to Magdalena Bay. They are most abundant in 20 to 50 fathoms, but occur both shallower and deeper. They prefer sandy or sandy-mud bottoms, living directly on the substrate. An extremely large individual might reach 12 inches. Twenty-nine of the otoliths belonged to this species (Figure 16).

Citharichthys stigmaeus Jordan and Gilbert—speckled sanddab

Trawling with a fine-meshed net has revealed that speckled sanddabs are one of the most abundant bottom-living species inhabiting California's shallow coastal waters. They occur profusely from about Vancouver Island to Magdalena Bay, usually in 5 to 25 fathoms, occasionally as deep as 70 fathoms and rarely in 100. They live mostly on a sandy or firm sandy-mud substrate, and adults seldom are 5 inches long. In all, 238 of their otoliths (Figure 17) were identified from this deposit.

Citharichthys spp.—sanddabs

Twenty-three otoliths were unquestionably from sanddabs, but they were so badly worn or fragmented I was unable to assign specific names. They probably were from either speckled or Pacific sanddabs, but some may have been from *C. xanthostigma* Gilbert (longfin sanddab), the third and only other species inhabiting our waters at present.

Pleuronectidae—righteyed flounders

Lyopsetta exilis (Jordan and Gilbert)—slender sole

Slender soles are almost as abundant in deeper waters (70 to 100 fathoms) as speckled sanddabs are in shallow areas. They have been captured all the way from Alaska to Cedros Island, typically on sandy-mud or muddy bottoms, occasionally as shallow as about 30 fathoms. Although large individuals may reach lengths of 12 inches, they are slender and thin, and seldom weigh more than a few grams. A single slender sole otolith (Figure 18) was found.

Pleuronichthys cf. *ritteri* Starks and Morris—spotted turbot

Spotted turbots are captured in relatively shallow water (1½ to 25 fathoms, but mostly less than 10) over sandy-mud or muddy bottoms from about Santa Barbara to Magdalena Bay. Four species of *Pleuronichthys* inhabit our waters and the otoliths of all are quite similar, but the single turbot otolith in this deposit (Figure 19) seemed to fit *P. ritteri* best.

Parophrys vetulus Girard—English sole

Off southern California, English soles are usually caught in 10 to 70 fathoms of water, moving inshore and offshore with changing seasons. The species ranges throughout the continental shelf area between about Alaska

and Cedros Island. They prefer sandy-mud or muddy bottoms, where they feed upon small mollusks, brittle starfish, polychaete worms, and other invertebrate organisms inhabiting these substrates. A single English sole otolith (Figure 20) was identified.

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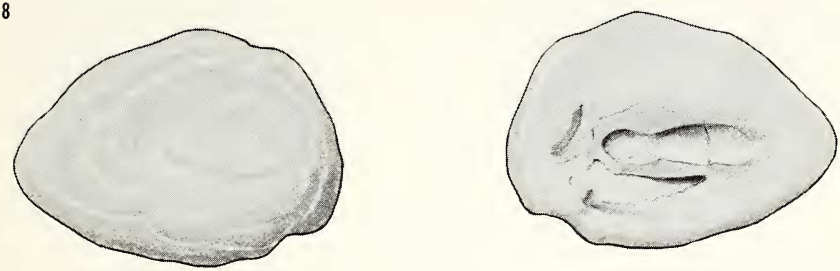

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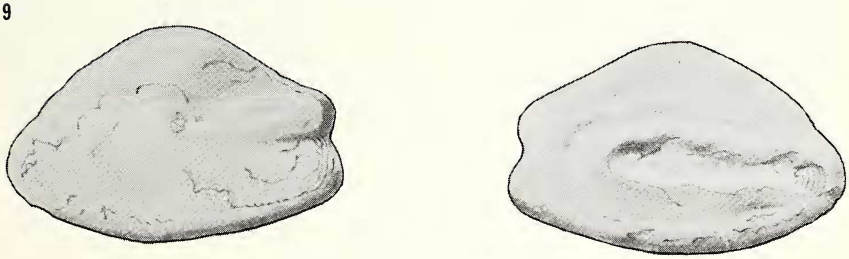

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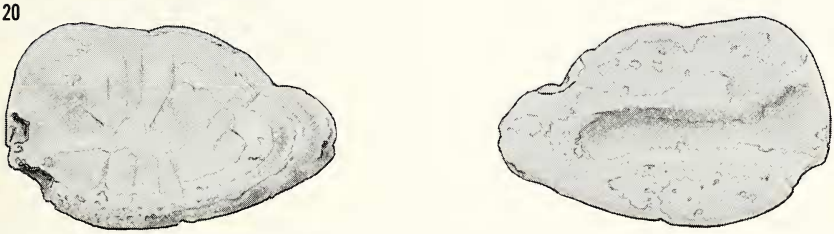

Figure 18. Left sagitta of slender sole, *Lyopsetta exilis* (length 3.5 mm, LACMIP 59). Left, outer face; right, inner face.

Figure 19 Left saggita of turbot, *Pleuronichthys* cf. *ritteri* (length 3.2 mm, LACMIP 59). Left, outer face; right, inner face.

Figure 20. Right sagitta of English sole, *Parophrys vetulus* (length 6.0 mm, LACMIP 59). Left, outer face; right, inner face.

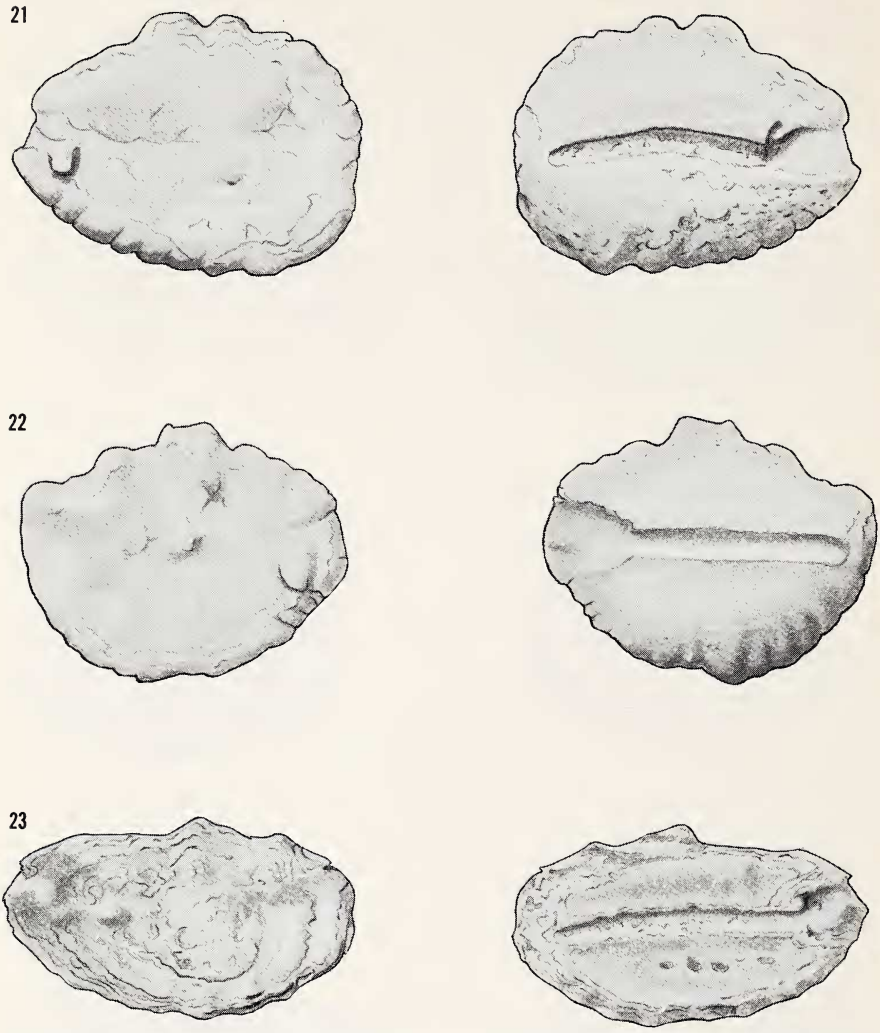

Figure 21. Left sagitta of grunion, *Leuresthes tenuis* (length 2.9 mm, LACMIP 59). Left, outer face; right, inner face.

Figure 22. Right sagitta of topsmelt, *Atherinops affinis* (length 3.5 mm, LACMIP 59). left, outer face; right, inner face.

Figure 23. Left sagitta of jacksmelt, *Atherinopsis californiensis* (length 5.3 mm, LACMIP 59). Left, outer face; right, inner face.

Atherinidae—silversides

Leuresthes tenuis (Ayres)—California grunion

California grunion range as far north as Monterey Bay and south nearly to Magdalena Bay, but they are not often seen north of Point Conception. They are most often found in loose schools or aggregations within a short distance of shore in water 15 to 40 feet deep. At spawning, adults seek out sandy beaches where eggs are deposited intertidally beneath the sand. Considerable spawning also takes place along firm sandy-mud shorelines of most coastal embayments. A large adult might be 8 inches long. There were six grunion otoliths (Figure 21) in this deposit.

Atherinopsis californiensis Girard—jacksmelt

Jacksmelt are found between Oregon and Santa Maria Bay, Baja California. They prefer murky water over sandy bottoms, but are not restricted to such areas. They typically form loose schools or aggregations close to the surface in water 5 to 100 feet deep. Oftentimes they move into quiet waters of back bays and harbors. Three of the otoliths were from jacksmelt (Figure 23).

Atherinops affinis (Ayres)—topsmelt

Four subspecies of topsmelt inhabit almost every marine habitat known between northern Oregon and Magdalena Bay. They often school or aggregate with jacksmelt. They usually are found at or near the surface, seldom any great distance offshore, where the bottom is sandy or sandy-mud. Many are seen in sloughs, back bays, and harbors, and many others inhabit offshore kelp beds. A single otolith was from a topsmelt (Figure 22).

Sphyraenidae—barracudas

Sphyraena argentea Girard—California barracuda

During some warmwater years, barracuda wander great distances north of their usual haunts, thus they have been reported from Alaskan waters on a few occasions. Typically they are found nearshore in fairly large schools between about Point Conception and Magdalena Bay. Young fish frequently "invade" quiet waters of back bays and harbors. Individuals weighing more than 10 pounds (18 is probably a top weight) are almost exclusively females. A broken otolith (Figure 24) was unquestionably from a fairly large, adult barracuda.

Figure 24. Left sagitta of California barracuda, *Sphyraena argentea* (length to break 10.7 mm, LACMIP 59). Left, outer face; right, inner face.

Pomadasyidae—grunts

Anisotremus davidsoni (Steindachner)—sargo

The sargo's distribution is usually reported as Point Conception south to Cape San Lucas and in the Gulf of California; however, there is some question as to whether they actually occur south of Magdalena Bay and in the lower Gulf. They usually inhabit shallow-water areas, where they aggregate around

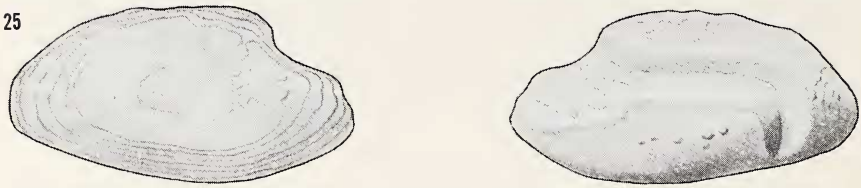

Figure 25. Right sagitta of sargo, *Anisotremus davidsoni* (length 9.8 mm, LACMIP 59). Left, outer face; right, inner face.

pier pilings, rocky outcroppings, and similar objects. Frequently small schools are observed moving over sandy bottoms along the open coast. There was a single sargo otolith in this deposit (Figure 25).

Sciaenidae—croakers

Micropogon ectenes Jordan and Gilbert—berrugato

This southern spcies hasn't been taken within several hundred miles of California during man's tenure here. They usually are fairly abundant in Magdalena Bay, throughout the Gulf of California, and south perhaps to Panama. They prefer shallow embayments and similar habitat where the water is relatively quiet, and the bottom is firm sandy-mud. Both berrugato otoliths in this deposit were from adult specimens (Figure 26).

Umbrina roncador Jordan and Gilbert—yellowfin croaker

Yellowfin croakers are found in shallow water from about Point Conception south to Magdalena Bay. They usually live close to the bottom where the substrate is sand, sandy-mud, or firm mud. They seldom travel any great distance outside the surf zone, but often enter back bays and estuaries, sometimes in fairly dense aggregations. The 13 yellowfin croaker otoliths were from juveniles and adults alike (Figure 27).

Genyonemus lineatus (Ayres)—white croaker

This gregarious species is so abundant in shallow water over most of its usual range (San Francisco to Magdalena Bay), and takes bait so readily, it usually is considered a nuisance and has many derogatory names applied to it by sportfishermen. During some years, they travel considerable distances north of their usual haunts, and thus have been reported from Vancouver Island on rare occasions. Most of the time they "hang out" on sandy, sandy-

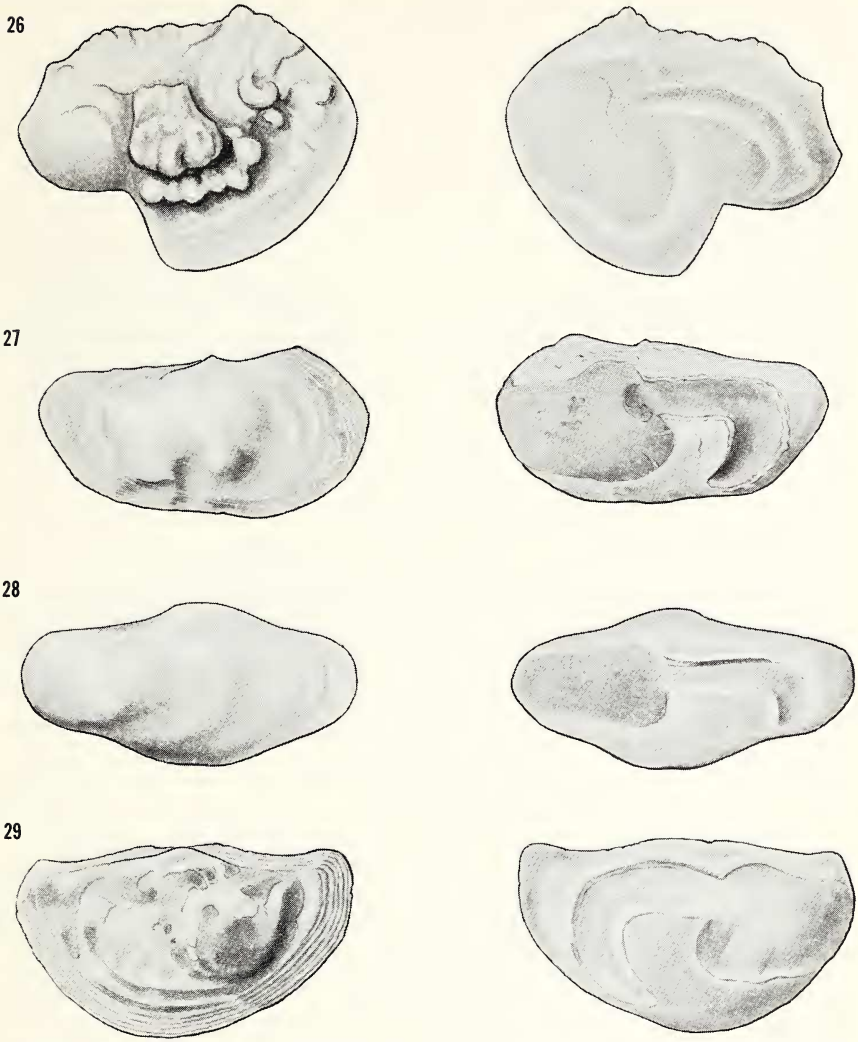

Figure 26. Right sagitta of berrugato, *Micropogon ectenes* (length 20.5 mm, LACMIP 59). Left, outer face; right, inner face.

Figure 27. Right sagitta of yellowfin croaker, *Umbrina roncador* (length 12.4 mm, LACMIP 59). Left, outer face; right, inner face.

Figure 28. Right saggita of white croaker, *Genyonemus lineatus* (length 8.5 mm, LACMIP 59). Left, outer face; right, inner face.

Figure 29. Left saggita of spotfin croaker, *Roncador stearnsi* (length 12.2 mm, LACMIP 59). Left, outer face; right, inner face.

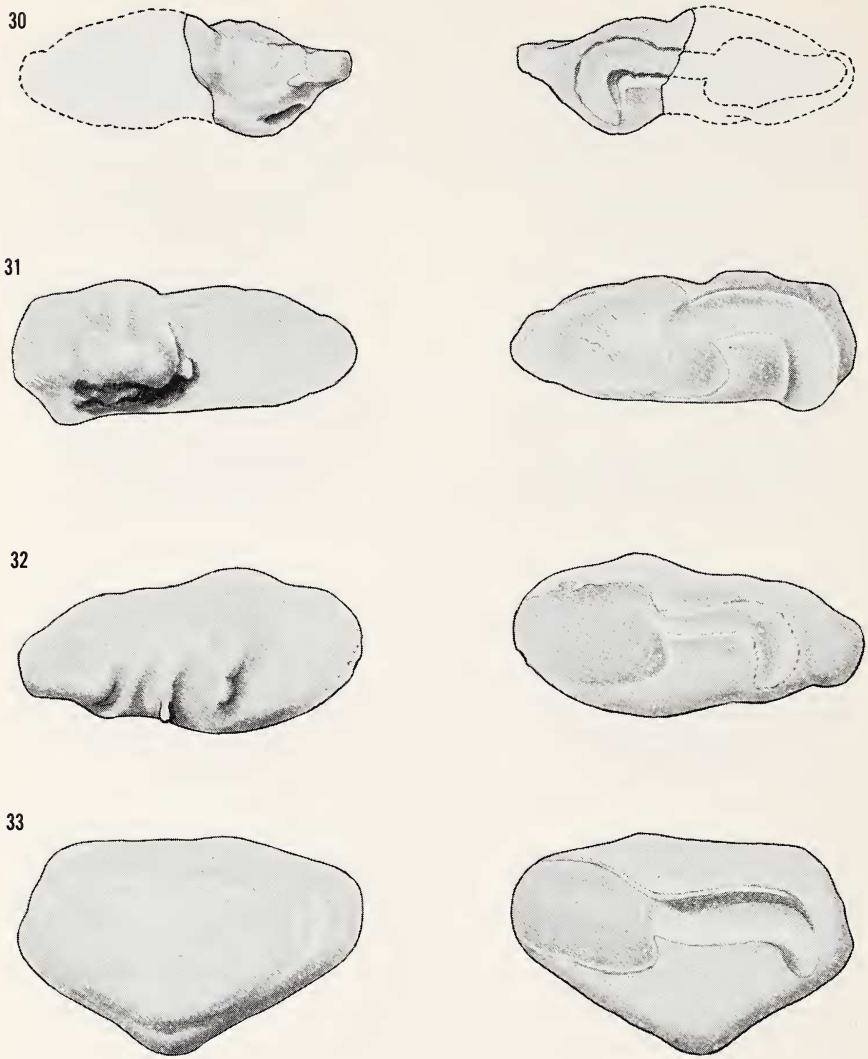

Figure 30. Left sagitta of California corbina, *Menticirrhus undulatus* (length to break 3.8 mm, LACMIP 59). Left, outer face; right, inner face.

Figure 31. Right sagitta of white seabass, *Cynoscion nobilis* (length 21.5 mm, LACMIP 59). Left, outer face; right, inner face.

Figure 32. Right sagitta of striped corvina, *Cynoscion reticulatus* (length 9.2 mm, LACMIP 59). Left, outer face; right, inner face.

Figure 33. Right sagitta of queenfish, *Seriphus politus* (length 7.6 mm, LACMIP 59). Left, outer face; right, inner face.

mud, or firm mud bottoms. They sometimes are caught in shallow bays and estuaries, but are equally at home in 100 fathoms. The 217 white croaker otoliths (Figure 28) were from about equal numbers of juveniles and adults.

Roncador stearnsi (Steindachner)—spotfin croaker

These desirable sport fishes are known from about Point Conception to San Juanico Bay, Baja California, where they live along beaches and in bays over bottoms varying from coarse sand to heavy mud. They seldom are caught in depths greater than 10 fathoms. The 19 spotfin croaker otoliths (Figure 29) were from juveniles as well as large adults.

Menticirrhus undulatus (Girard)—California corbina

California corbinas have been reported from Point Conception to San Juanico Bay; however, a species in the upper Gulf of California is very similar and may be identical. They live along the bottom and have been noted in water from a few inches to about 45 feet deep. They prefer coarse sand or sandy-mud, especially where sand crabs (*Emerita*) abound. A broken otolith was unquestionably from an adult corbina (Figure 30).

Cynoscion nobilis (Ayres)—white seabass

This choice game fish rarely is found north of San Francisco, but during a recent warmwater period a few individuals were caught at Juneau, Alaska. To the south, they abound along sandy beaches and off rocky headlands at least to Magdalena Bay, and fair numbers also occur in the northern Gulf of California. Young fish are usually in shallower water than adults, often being abundant in bays and estuaries. The five white seabass otoliths were from fairly large adults (Figure 31). Very large adults may weigh as much as 70 pounds.

Cynoscion reticulatus (Günther)—striped corvina

This southern species has not been reported north of Santa Maria Bay, Baja California, in modern times. It ranges from there to Panama, and is especially common throughout the Gulf of California. They prefer sandy-mud or firm-mud bottoms of embayments and quiet offshore waters. Numerous individuals are captured by shrimp trawlers operating in 5 to 30 fathoms, and many are caught by sport gear in a few feet of water near the surf zone. The four striped corvina otoliths were all from young fish (Figure 32). The largest adult I have seen, weighed just under 5 pounds.

Seriphus politus Ayres—queenfish

Queenfish have been captured from Yaquina Bay, Oregon, to San Juanico Bay, but they are not common north of Point Conception. They are a gregarious species, and are extremely abundant throughout much of their range, where they prefer relatively quiet waters. They often inhabit coastal bays and

sloughs, living throughout the water column, particularly where the bottom is sandy or firm sandy-mud. Their otoliths were among the most numerous in this deposit; the 275 I found represented all sizes of fish from the smallest juveniles to the largest adults (Figure 33). Large adults seldom exceed a foot in length.

Embiotocidae—surfperches

Phanerodon furcatus Girard—white seaperch

This species seldom takes a hook, but is commonly netted between about San Francisco (rarely to Vancouver Island) and Point Cabras, Baja California. They are relatively small schooling fishes, and usually live throughout the water column, but are commonest just off the bottom. Their favorite substrate is coarse sand or cobbles, but they also are found in bays over mud bottoms and in kelp beds among rocks. Judging from their present numerical abundance I anticipated finding more than the nine white seaperch fossil otoliths. (Figure 34).

Cymatogaster aggregata Gibbons—shiner perch

Shiner perch literally infest much of their range (Port Wrangel, Alaska, to Santo Tomas Point, Baja California). They prefer calm water with smooth

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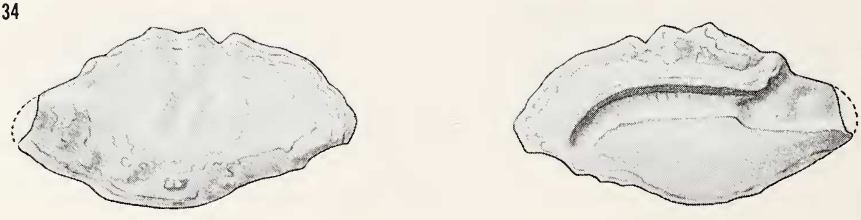

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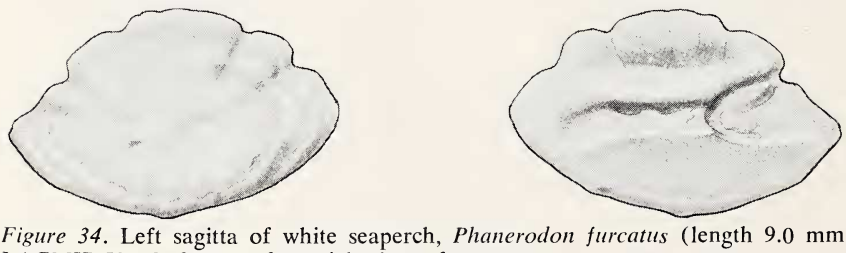

Figure 34. Left sagitta of white seaperch, *Phanerodon furcatus* (length 9.0 mm, LACMIP 59). Left, outer face; right, inner face.

Figure 35. Left sagitta of shiner perch, *Cymatogaster aggregata* (length 5.0 mm, LACMIP 59). Left, outer face; right, inner face.

bottoms, where "swarms" of them mingle with other small fishes around pier and wharf pilings, over eel grass beds, and throughout the waters between. They have been trawled from 400 feet of water, but are most abundant shallower than 50 feet. A large individual would be around 5 inches long. Only six of the otoliths were from shiner perch (Figure 35).

Labridae—wrasses

Pimelometopon pulchrum (Ayres)—California sheephead

Sheephead seldom wander very far from a rocky substrate. They have been caught in Monterey Bay a few times, but are usually found from Point Conception to Cape San Lucas and throughout the Gulf of California. They usually live at or near the bottom in water 20 to 100 feet deep, but may go either shallower or deeper. Large males sometimes will weigh just over 30 pounds (at about 3 feet), but most individuals weigh less than 20. Sheephead were represented by one pharyngeal bone from a juvenile and six assorted teeth.

Scorpaenidae—rockfishes

Sebastodes paucispinis (Ayres)—bocaccio

Except in the young stages, bocaccio are considered a deep-water species (65 to 175 fathoms) off southern California. Schools of juveniles, however, often move inshore where quantities are caught from piers, docks, and similar structures. Adults have been caught from Queen Charlotte Sound to San Carlos, Baja California. They occur over broken (rocky) as well as smooth bottoms, and are especially numerous over firm sandy-mud where trawlers capture considerable tonnages each year. Six of the rockfish otoliths apparently were from bocaccio, mostly small individuals (Figure 36). Large adults may be 3 feet long and weigh 15 pounds.

Sebastodes jordani Gilbert—shortbelly rockfish

This small rockfish has been taken throughout the area between Washington and Ensenada, Baja California. Sometimes they show up in water 10 to 15 fathoms deep, especially when young, but usually they stay in deeper water, perhaps to 150 fathoms. They prefer living slightly above the bottom over smooth sandy-mud substrates. Two of the otoliths were from this species (Figure 37).

Sebastodes aurora (Gilbert)—aurora rockfish

Aurora rockfish are not often seen off southern California, even though they are known from the Columbia River to San Diego. They seldom are caught shallower than 50 fathoms, and range into 275 fathoms. They are caught at or near the bottom over a variety of substrates, but seem to prefer rocky habitat. A single otolith was from this species (Figure 38).

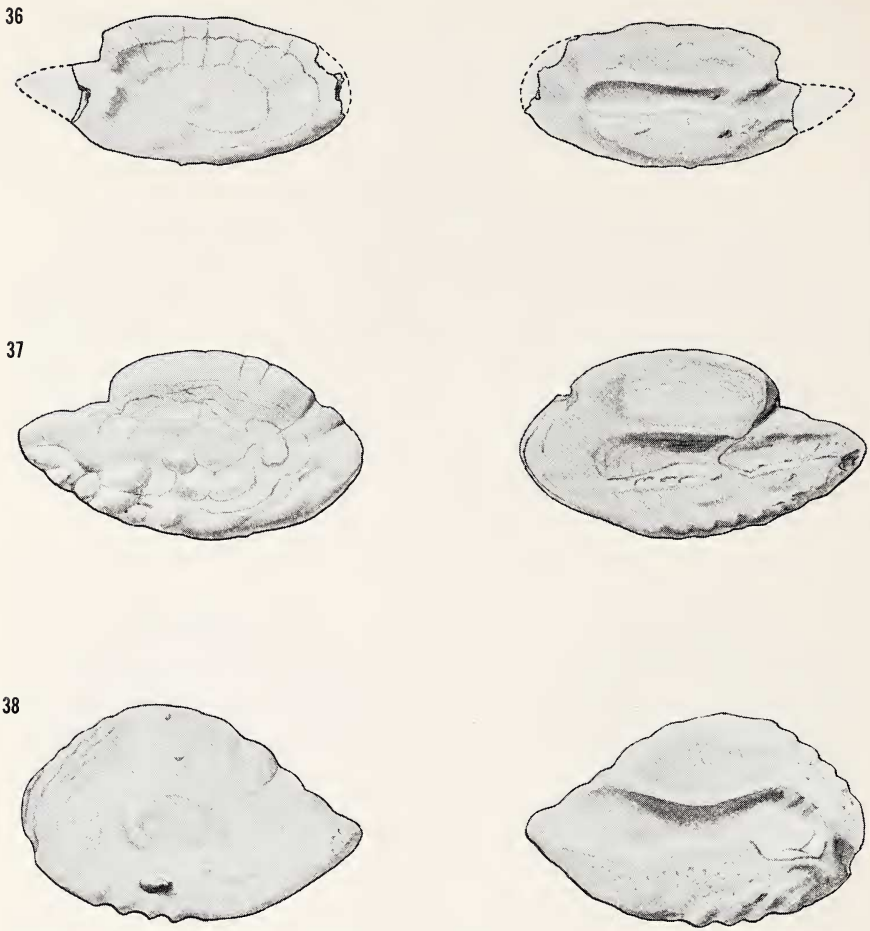

Figure 36. Left sagitta of bocaccio, *Sebastodes paucispinis* (length of fragment 7.3 mm, LACMIP 59). Left, outer face; right, inner face.

Figure 37. Left sagitta of shortbelly rockfish, *Sebastodes jordani* (length 6.4 mm, LACMIP 59). Left, outer face; right, inner face.

Figure 38 Right sagitta of aurora rockfish, *Sebastodes aurora* (length 6.3 mm, LACMIP 59). Left, outer face; right, inner face.

Sebastodes diploproa (Gilbert)—splitnose rockfish

These are among the commoner rockfish in fairly deep water (usually 100 to 250 fathoms) between Vancouver Island and the Coronado Islands, Baja California. They prefer living on or just above a smooth sandy-mud or firm mud bottom, but occasional catches are made over rocky substrates.

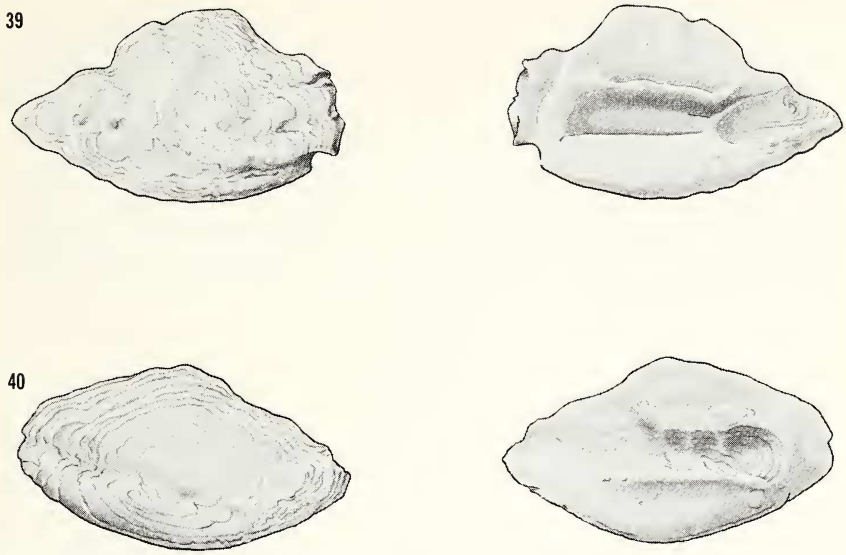

Figure 39. Left sagitta of splitnose rockfish, *Sebastodes diploproa* (length 12.9 mm, LACMIP 59). Left, outer face; right, inner face.

Figure 40. Right sagitta of swordspine rockfish, *Sebastodes rhodochloris* (length 7.0 mm, LACMIP 59). Left, outer face; right, inner face.

They never attain very large sizes (16 inches maximum) and are of little commercial value except for mink food. One otolith was from a large splitnose rockfish (Figure 39).

Sebastodes cf. *rhodochloris* (Jordan and Gilbert)—swordspine rockfish

Two of the rockfish otoliths (Figure 40) seemed to identify with this small species, which occurs between about San Francisco and Guadalupe Island, Baja California. They prefer depths of 50 to 70 fathoms, but have been taken in 120, usually over rocky substrate.

Sebastodes spp.—various species of rockfish

Thirteen rockfish otoliths were so badly fragmented or worn they could not be identified to species. Some of the smaller ones seemed to be from bocaccio, but others could have come from any of the 50 rockfish species known in our waters.

Cottidae—sculpins

Chitonotus pugetensis (Steindachner)—roughback sculpin

These small fishes (adults may reach 5 or 6 inches) are fairly abundant on sandy or sandy-mud bottoms in 20 to 60 fathoms between northern British

Figure 41. Right sagitta of roughback sculpin, *Chitonotus pugetensis* (length 3.0 mm, LACMIP 59). Left, outer face; right, inner face.

Columbia and Santa Maria Bay, Baja California. Occasional individuals may be taken in water as shallow as 5 to 10 fathoms. There was one roughback sculpin otolith in this deposit (Figure 41).

Gobiidae—gobies

Lepidogobius lepidus (Girard)—bay goby

As the common name implies, this small goby (adults reach 4 or 5 inches) is most at home in the sheltered waters of bays, sloughs, and harbors where they sometimes are taken in the subtidal area. Occasionally, they are trawled

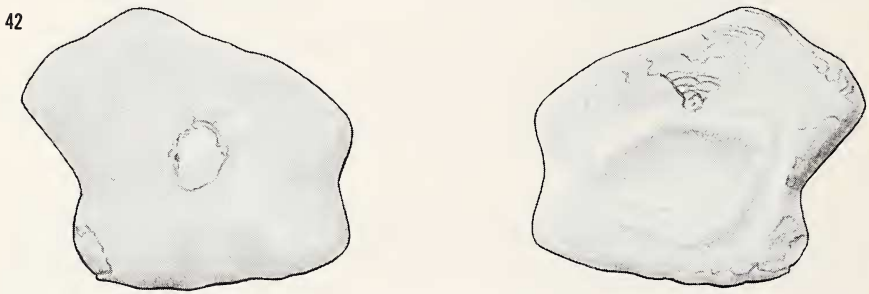

Figure 42. Left sagitta of bay goby, *Lepidogobius lepidus* (length 2.7 mm, LACMIP 59). Left, outer face; right, inner face.

in fair numbers from depths as great as 40 to 50 fathoms. Their usual range is from northern Vancouver Island to Ensenada. One otolith was from a bay goby (Figure 42).

Batrachoididae—toadfishes

Porichthys notatus Girard—plainfin midshipman

Plainfin midshipmen are among the half-dozen most abundant species in trawl catches made in intermediate depths (50 to 120 fathoms). In some localities between southeastern Alaska and Cedros Island, they seasonally move into the intertidal zone. On the other hand, they have also been trawled from 200 fathoms. They prefer firm mud or muddy bottoms during much of the year, seeking out rocky habitat for spawning. Most of the 161 otoliths from this species (Figure 43) were from young individuals.

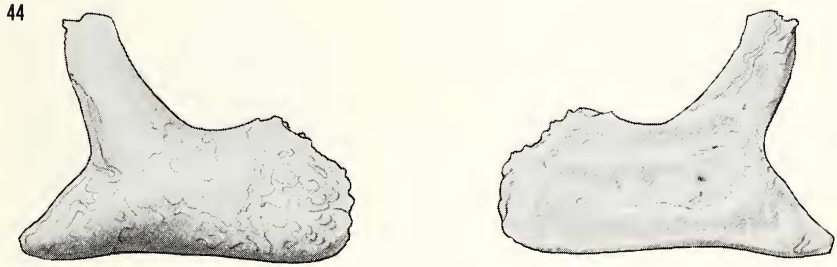

Figure 43. Left sagitta of plainfin midshipman, *Porichthys notatus* (length 6.3 mm, LACMIP 59). Left, outer face; right, inner face.

Figure 44. Left sagitta of specklefin midshipman, *Porichthys myriaster* (length 9.2 mm, LACMIP 59). Left, outer face; right, inner face.

Porichthys myriaster Hubbs and Schultz—specklefin midshipman

Specklefin midshipmen are neither as abundant as *P. notatus* nor so wide-ranging, being known from about Point Conception to Magdalena Bay. They often seek out rocky intertidal areas for spawning, but at other times move into depths of 50 fathoms or so. Their habits and habitat preferences are similar to those of *P. notatus*. Only 15 of the otoliths were from specklefin midshipmen (Figure 44).

Ophidiidae—cusk-eels

Otophidium taylori (Girard)—spotted cusk-eel

Spotted cusk-eels have been caught from about Humboldt Bay, California, to San Cristobal Bay, Baja California. They are fairly abundant throughout this range (in from 10 to at least 130 fathoms), but because of their secretive habits they are not often caught. They often are found in association with rocks, particularly where they form loose jumbles intermixed with sandy-

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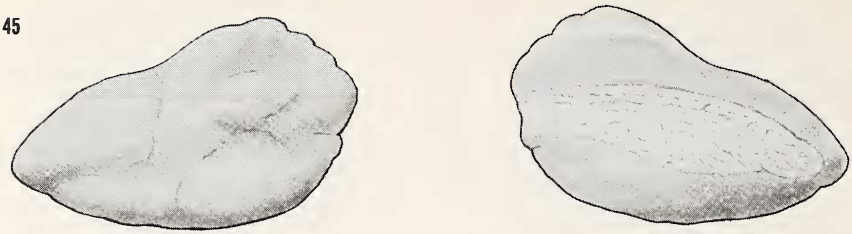

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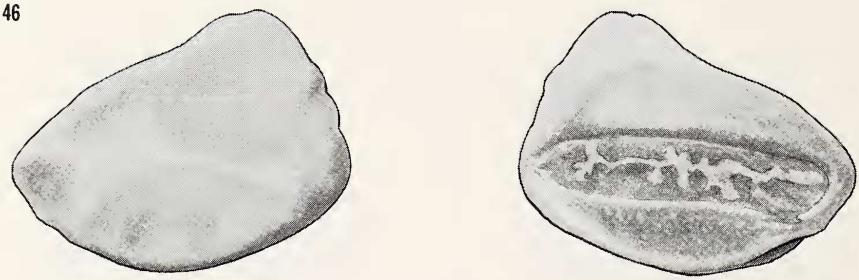

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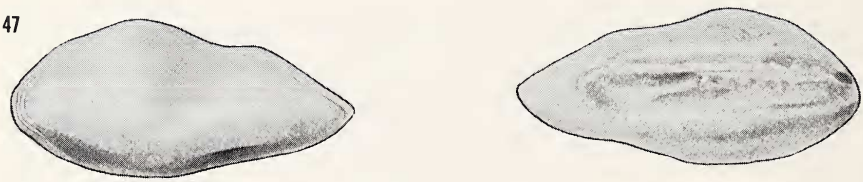

Figure 45. Right sagitta of spotted cusk-eel, *Otophidium taylori* (length 7.6 mm, LACMIP 59). Left, outer face; right, inner face.

Figure 46. Right sagitta of basketweave cusk-eel, *Otophidium scrippsae* (length 7.8 mm, LACMIP 59). Left, outer face; right, inner face.

Figure 47. Left sagitta of giant cusk-eel, *Lepophidium negropinna* (length 12.3 mm, LACMIP 59). Left, outer face; right, inner face.

mud or mud. They hide among these rocks during the daytime, moving into the open at night. When startled, cusk-eels will burrow rapidly tail-first into the substrate. There were 83 otoliths from this species (Figure 45).

Otophidium scrippsae Hubbs—basketweave cusk-eel

This species has habits similar to those of *O. taylori,* but seems to live in shallower water (intertidal to 20 fathoms) over a more restricted range (Point Conception south to Turtle Bay, Baja California). Their otoliths were more abundant (140 were found) than those of *O. taylori* in this deposit (Figure 46).

Lepophidium negropinna Hildebrand and Barton—giant cusk-eel

This species has not been recorded north of Cedros Island during modern times. It ranges from there throughout the Gulf of California to Talara, Peru. Their habits are probably similar to those of *Otophidium,* because specimens can be trawled over relatively smooth, firm bottoms. Two of the otoliths were from this species (Figure 47), both from fairly large individuals (perhaps 15 to 18 inches long).

Unidentifiable Teleost Remains

Thirty-three otoliths were too badly worn or fragmented to classify with any certainty. I doubt if any of these represented species not enumerated above. Other unidentifiable remains included 25 assorted vertebrae (mostly small), and a half-dozen broken-off neural spines and/or fin spines. A single badly-eroded pharyngeal bone also could not be identified, although it appeared to be from an embiotocid perch.

DISCUSSION

The city of Los Angeles has been conducting a surveillance of its Hyperion sewer outfall in Santa Monica Bay since 1957, and 32 of the 35 teleosts discussed above have been common constituents of their trawl catches. The other three (striped corvina, berrugato, and giant cusk-eel) are southern species, and haven't been taken within several hundred miles of California within modern times (Figure 48).

Only the longnose shark among the elasmobranchs has not been caught as far north as Playa del Rey during modern times. All of the others are fairly abundant in Santa Monica Bay, but some are not found there every year. Hammerheads and carcharhinid sharks are "southerners" and only appear during warmwater years, while the sevengill is a "northerner" and shows up most frequently when the bay waters are cold (Figure 49).

Thus, all forms identified in the Playa del Rey formation are still extant, and most can be captured in relatively shallow water adjacent to the site of this deposit.

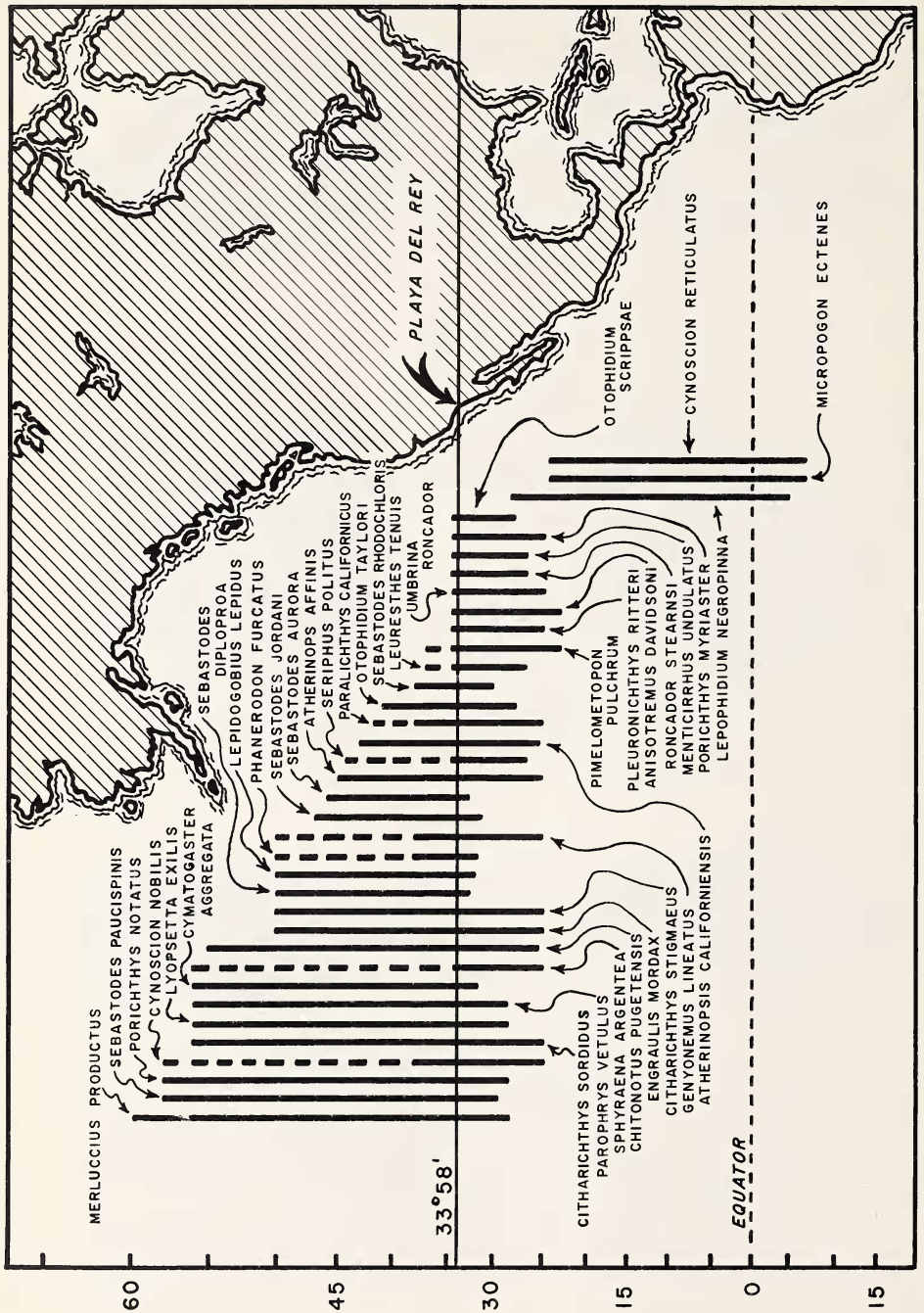

Figure 48. Present-day geographic distributions of the 36 species of teleost fishes identified from the Playa del Rey deposit (LACMIP 59, lat. 33° 58′ N.). Solid lines depict usual latitudinal distribution broken lines represent infrequent movement or migrations.

It is extremely gratifying to find the fish fauna so compatible with the various invertebrate faunas described by Willett (1937). My findings are in no way at odds with Valentine's (1961) statement that the habitat appears to have been a fine-grained silty sand, typical of a quiet-water embayment 10 to 12 fathoms deep.

The few "northern" fish remains (rockfishes, hake, English sole, and slender sole) were mostly badly worn, broken, and uncommon, as were the few northern mollusks that Willett found. Not many of the typical shallow-water and "southern" forms showed such signs of wear and tear. In fact, most of the otoliths were in such excellent shape that I wondered if they had not resulted from a catastrophic die-off, perhaps from an extensive red-tide condition.

If they had been the partially digested remnants of meals eaten by predatory fishes, marine mammals, and birds, most of the otoliths would have shown some signs of erosion on their inner (concave) faces, as well as margins and outer faces. Such was not the case. I examined many of the otoliths from younger fishes to see if their margins would show annuli (growth zones) that would offer a clue as to the season of the year during which death had occurred, but was not able to come up with enough concrete information to hazard a guess.

The presence of southern forms among both elasmobranchs and teleosts, bears out the contention that this deposit was laid down when local ocean temperatures were several degrees warmer than they are today. When such oceanic warming does take place, there is a tendency for anomalies to occur among the various vertebrate and invertebrate faunas (Radovich, 1961). During these times prolific and extensive dinoflagellate blooms (red-tide) often are noted, sometimes in every month of the year. The killing power of such blooms has been amply demonstrated in Florida (Gunter *et al.*, 1948) and California (Reish, 1963) during the past two decades. There is no reason to believe that such phemenona did not occur during the Pleistocene also, or that their effects were any less damaging to marine animal aggregations or communities than they are today.

ACKNOWLEDGMENTS

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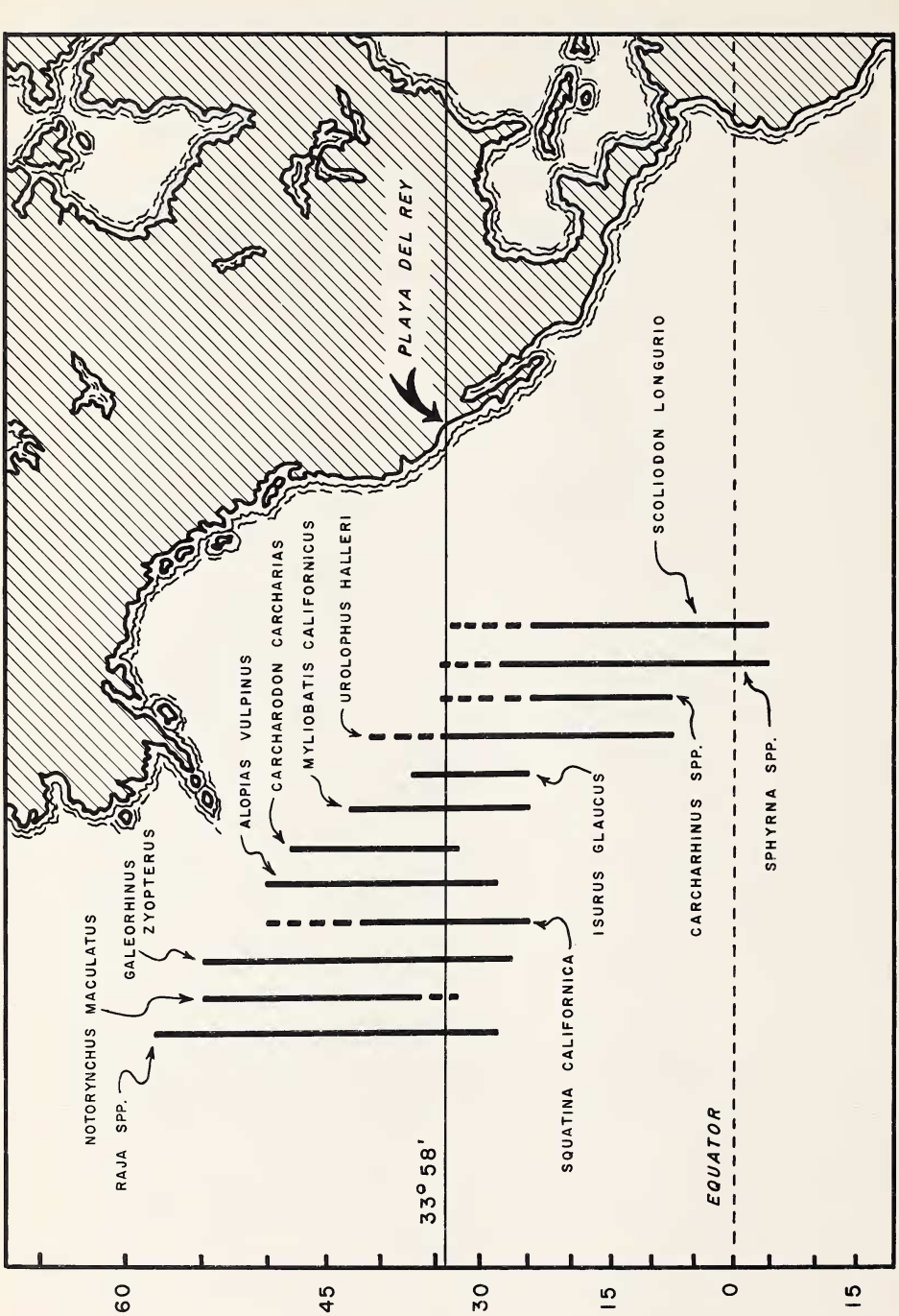

Figure 49. Present-day geographic distributions of the elasmobranchs identified from the Playa del Rey deposit (LACMIP 59, lat. 33° 58′ N.). Solid lines depict usual latitudinal distribution, broken lines represent infrequent movements or migrations.

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